

# A compact high performance time-of-flight mass spectrometer for the fast detection of vapor traces

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We have developed a compact time-of-flight mass spectrometer (TOF-MS) for direct measurements of nuclear masses. This device uses a given flight path repeatedly to achieve high mass resolving powers (see Fig.1). Unlike scanning mass spectrometers, such as RF-quadrupoles or ion traps, that record only a small fraction of the initially injected ions, this TOF-MS uses all ions available to produce a mass spectrum.

The compact geometry of a multi-pass TOF-MS allows the design of a portable instrument. Such a system (see Fig.2) has been implemented in a space craft for the ROSETTA mission of the ESA. Another device with an overall length of 450mm has provided excellent mass resolving powers as demonstrated in Figures 3 and 4.

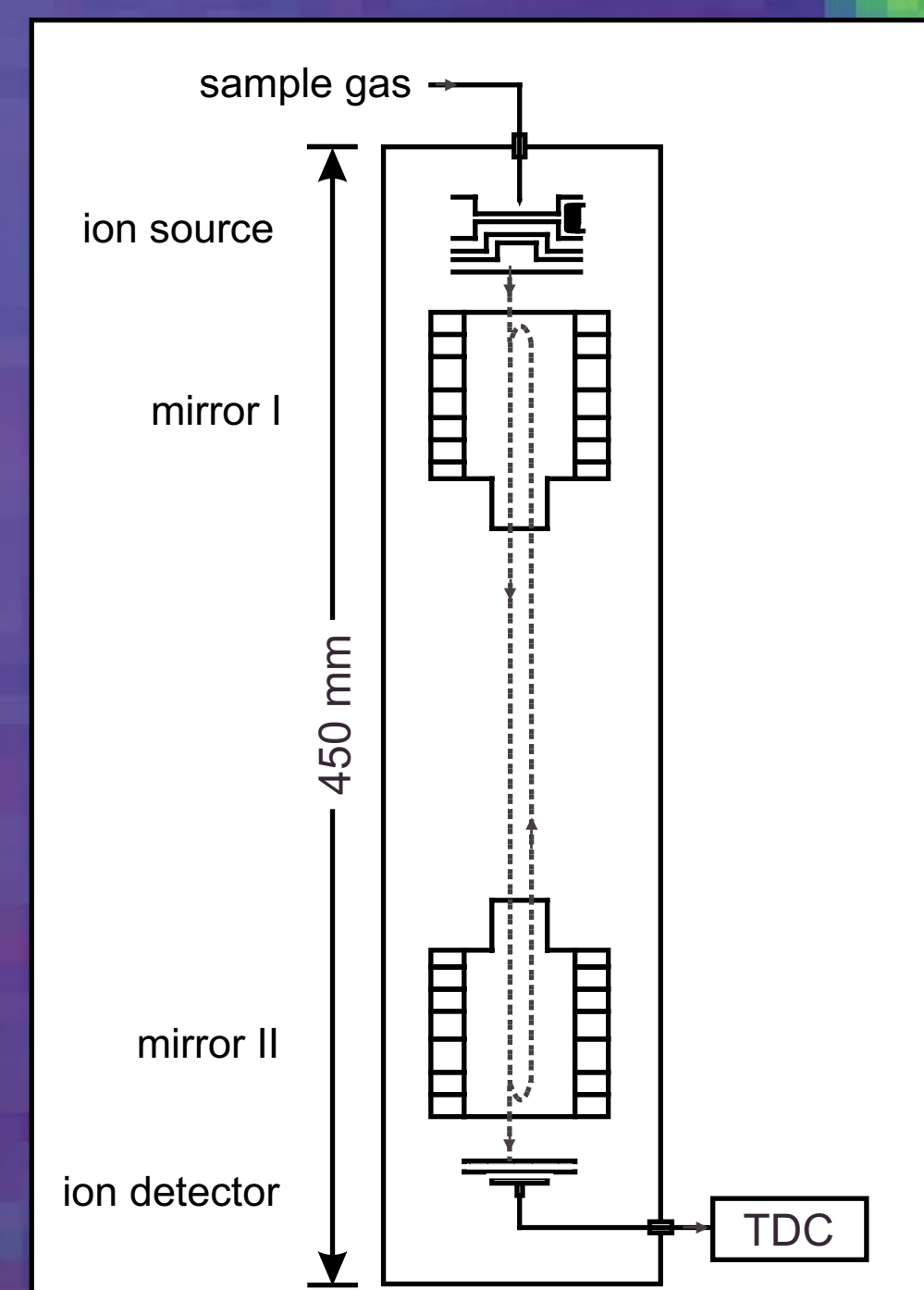


Fig.1 Principle of a multi-pass time-of-flight mass spectrometer that can provide high mass resolving powers  $m/\Delta m$  in a system of small physical size.

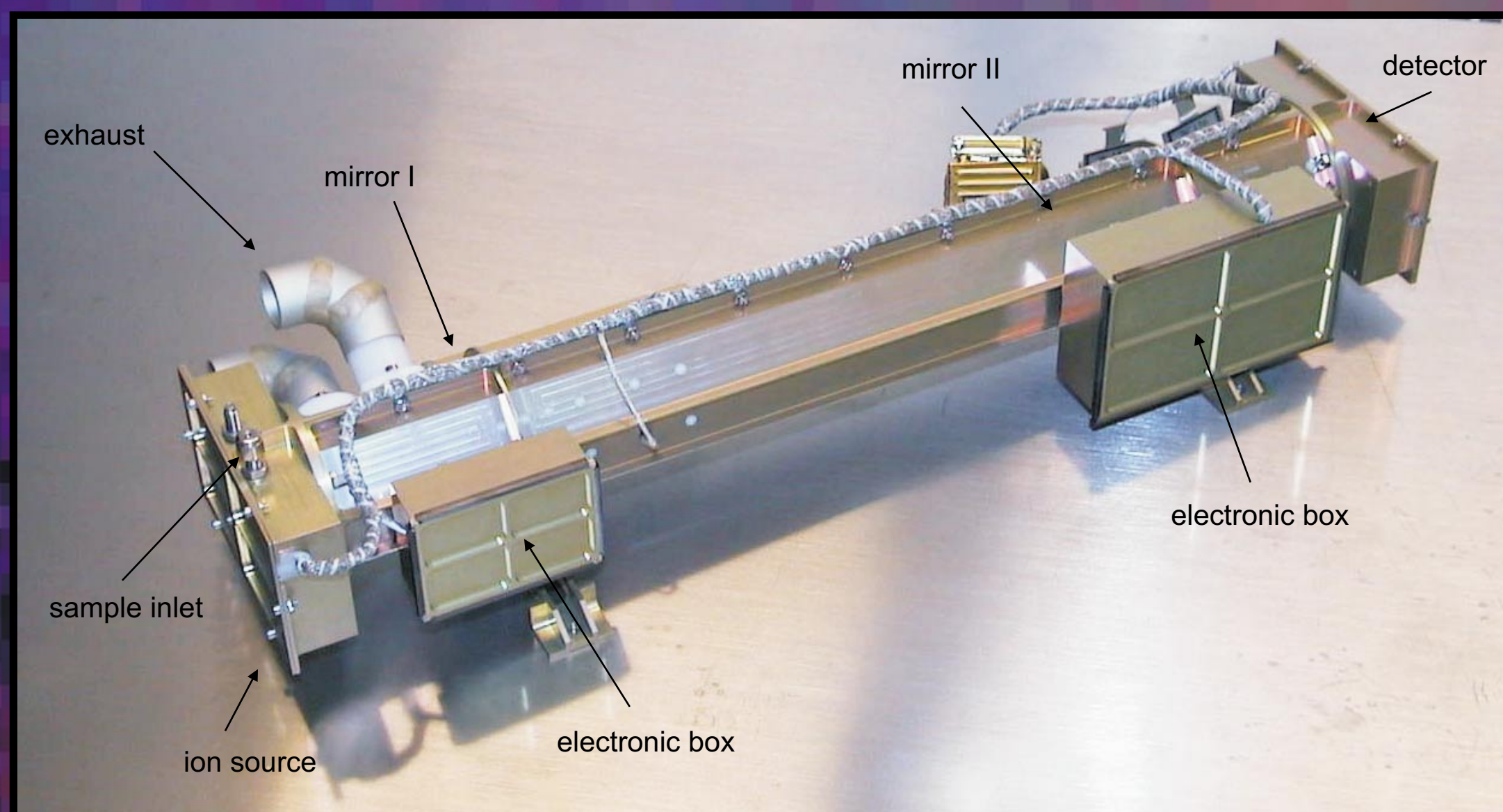


Fig.2 A multi-pass time-of-flight mass spectrometer that has an overall length of 420mm. The above instrument was built for a space craft experiment on the ROSETTA mission and includes all electronic supplies but no vacuum pumps. This instrument has been operated remotely and fulfilled the rigorous demands of a sturdy design, low weight (1000 g) and small power consumption.

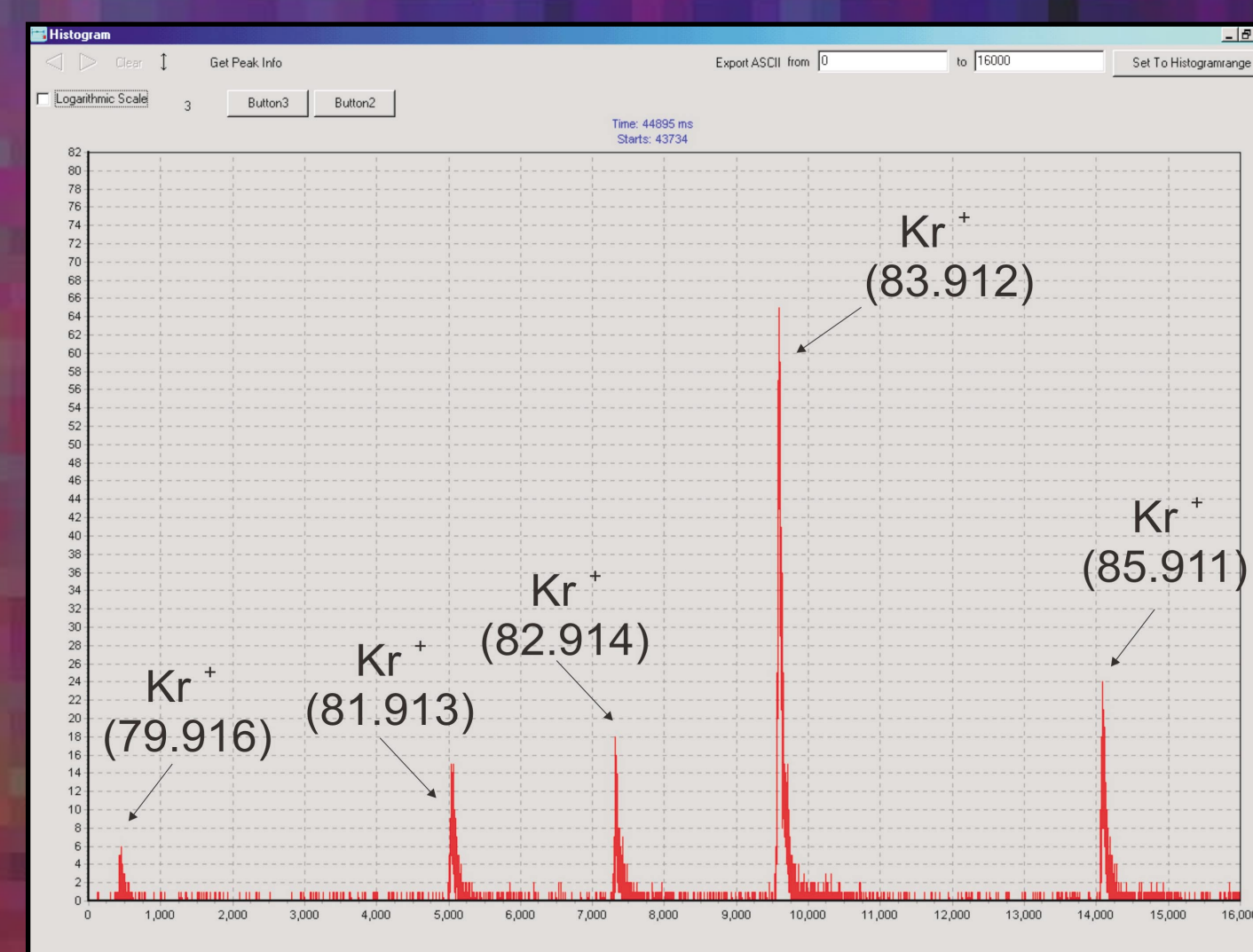


Fig.3 Mass spectrum of Kr-isotopes obtained by the system of Figs. 1 and 2 after 15 passes of the ions under consideration.

Mass resolving powers of the magnitude shown in Fig.4 are high enough to distinguish more than 90% of all organic substances from each other without the use of a gas chromatograph. This reduces the time required for a full sample analysis from many minutes to seconds or less. Using a membrane gas inlet system and an electron impact ion source in a system similar to that shown in Fig.2, gas admixtures of 0.1ppm could be identified.

Although an ion-mobility analyzer, in which ions are dragged by electric fields through a gas of about one atmosphere pressure, has a very much smaller specificity than a TOF-MS, it could advantageously be used as a prefilter. This should not slow down the analysis and, since a mobility spectrometer is only a few cm long, should not compromise the instrument's portability.

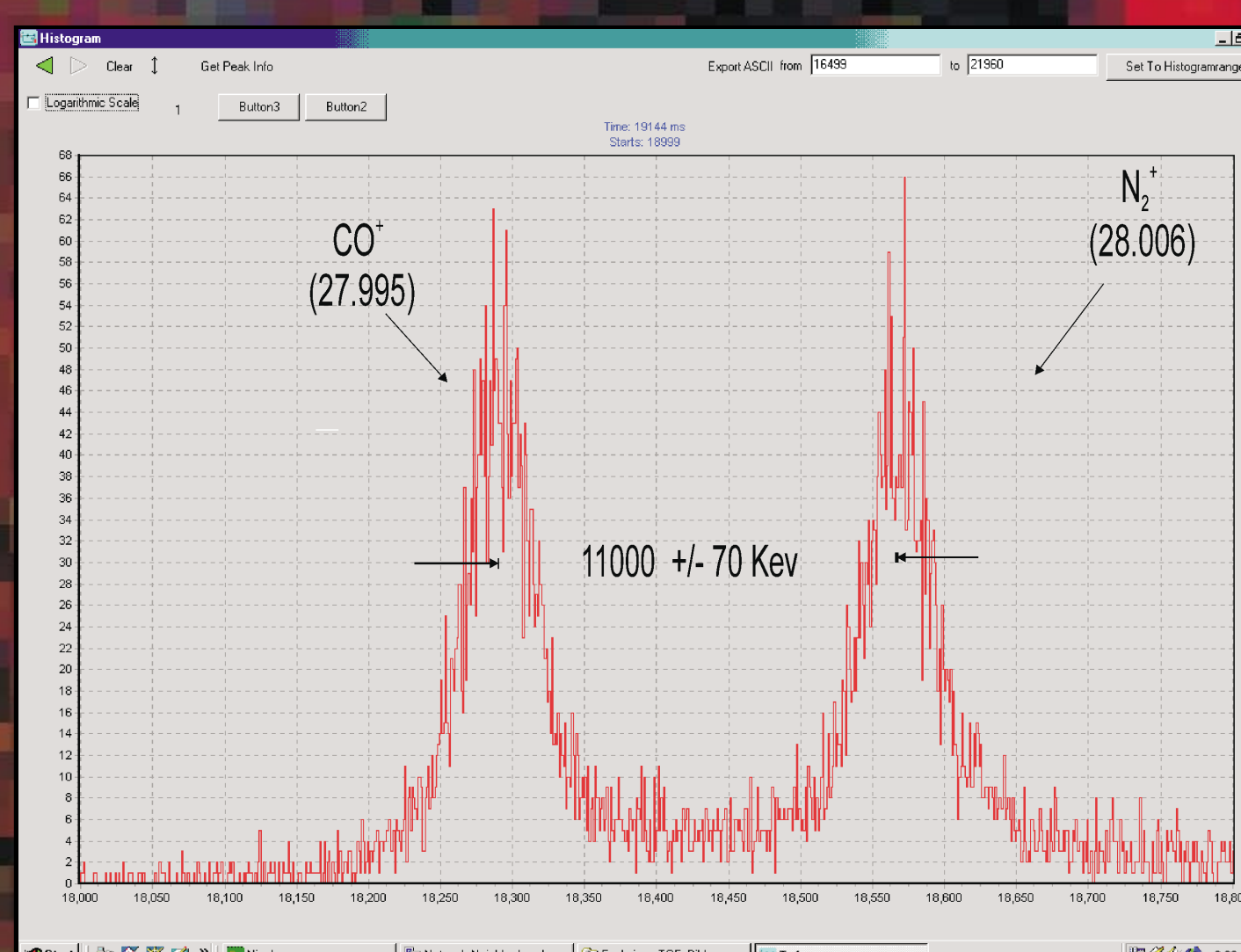


Fig. 4 Mass spectrum of a sample of CO-enriched air. Since the masses of CO and N<sub>2</sub> differ only by 39ppm they are well suited to illustrate the high mass resolving power obtained after the ions have passed 101 times through the multi-pass time-of-flight mass spectrometer, achieving mass resolving powers  $m/\Delta m \geq 20,000$ .